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4.2.9.1 First Level Maintenance

The first level of hardware maintenance shall include:

- a. Scheduled preventive maintenance
- b. Fault localization
- c. Replacement of failed units (LRUs)
- d. In-line testing and recalibration of repaired and replaced units

The test resources of the MTG shall be used as required for fault localization, testing, and calibration.

4.2.9.2 Second Level Maintenance

The WSC shall include a single HMD, located at the Danzante Ground Terminal, for the repair of failed units. The HMD shall be capable of restoring to serviceable condition failed units determined to be repairable. The HMD shall include test equipment, signal sources, printed circuit board testers, integrated circuit testers, test fixtures, and tools required to perform repairs to the individual piece-part level. The second level maintenance function shall be supported by a logistics program which provides a supply of spare parts for the timely repair of failed components.

4.3 Performance Requirements

This section specifies, directly and by reference to other relevant sections of this specification, the performance requirements of the WSC.

4.3.1 TDRS Support Performance

The Danzante, ~~and~~ Cacique ~~and~~ GRGT SGLTs shall be capable of operating with an assigned, on-orbit TDRS, with ~~an~~ orbital inclination ~~s not exceeding $\pm 7^\circ$ and with a nadir longitudes as specified in Table 4-1, between 39° west longitude and 180° west longitude. The GRGT SGLT shall be capable of operating with an assigned, on-orbit TDRS, with an orbit inclination of $\pm 7^\circ$ and with a nadir between 142° west longitude and 289° west longitude. The nadir longitudes specified in Table 4-1 are based on a minimum 5° elevation above the horizon mask for each ground terminal.~~

Table 4-1. Ground Terminal On-Orbit TDRS Visibility

<u>ORBITAL INCLINATION</u>	<u>DANZANTE NADIR LONGITUDES</u>	<u>CACIQUE NADIR LONGITUDES</u>	<u>GRGT NADIR LONGITUDES</u>
<u>0°</u>	<u>38° West to 180° West</u>	<u>42° West to 180° West</u>	<u>140° West to 291° West</u>
<u>$\pm 7^\circ$</u>	<u>42° West to 175° West</u>	<u>45° West to 175° West</u>	<u>142° West to 289° West</u>

4.3.2 Operational Availability

In a measurement interval of 10,000 hours, the Danzante and Cacique operational availability, as defined in Section 13.4, for providing forward and return customer and S-band TT&C services,

Table 5-2. Ku-band Transmit RF Characteristics

A. OPERATING FREQUENCY BAND	14.60 TO 15.225 GHz
B. EIRP (MINIMUM INCLUDING TRACKING LOSS) <ul style="list-style-type: none"> •A. DANZANTE <ul style="list-style-type: none"> 1. KSA 75.9 dBW 2. SSA 71.1 dBW 3. MA 64.1 dBW 4. COMMAND ADJUSTABLE IN AT LEAST TEN DISCRETE STEPS FROM 59 dBW TO 88 dBW 5. PILOT ADJUSTABLE IN AT LEAST THIRTY DISCRETE STEPS FROM 59 dBW TO 88 dBW •B. CACIQUE <ul style="list-style-type: none"> 1. KSA 73.5 dBW 2. SSA 71.1 dBW 3. MA 64.1 dBW 4. COMMAND ADJUSTABLE IN AT LEAST TEN DISCRETE STEPS FROM 54 dBW TO 83 dBW 5. PILOT ADJUSTABLE IN AT LEAST THIRTY DISCRETE STEPS FROM 54 dBW TO 83 dBW •C. GRGT <ul style="list-style-type: none"> 1. KSA 73.5-9 dBW 2. SSA 71.1 dBW 3. MA 64.1 dBW 4. COMMAND ADJUSTABLE IN AT LEAST TEN DISCRETE STEPS FROM 59.0 - 834.0 dBW 5. PILOT ADJUSTABLE IN AT LEAST THIRTY DISCRETE STEPS FROM 59.0 - 834.0 dBW 	
C. TRANSMIT GAIN (AT FEED PORT) <ul style="list-style-type: none"> •A. DANZANTE/CACIQUE 66.5 dBi, MINIMUM OVER THE TRANSMIT BAND •B. GRGT 61.6 dBi, MINIMUM OVER THE TRANSMIT BAND 	
D. SIDELOBE PATTERN <ul style="list-style-type: none"> •A. DANZANTE¹ $G \leq 29-25 \log_{10} \theta \text{ dBi} \quad 1^\circ < \theta < 36.4^\circ$ $G \leq -10 \text{ dBi} \quad 36.4^\circ \leq \theta \leq 180^\circ$ •B. CACIQUE SIDELOBE LEVELS SHALL BE 16 dB OR MORE BELOW THE MAIN LOBE. •C. GRGT¹ $G \leq 29-25 \log_{10} \theta \text{ dBi} \quad 1^\circ < \theta \leq 7^\circ$ $G \leq 32-25 \log_{10} \theta \text{ dBi} \quad 7^\circ < \theta < 48^\circ$ $G \leq -10 \text{ dBi} \quad 748^\circ \leq \theta \leq 180^\circ$ <p>WHERE G IS THE GAIN (IN dBi), AT ANY FREQUENCY IN THE SPECIFIED FREQUENCY BAND, AND θ IS THE OFF-BORESIGHT ANGLE IN DEGREES.</p> 	

Table 5-2. Ku-band Transmit RF Characteristics (Continued)

E. POLARIZATION	LINEAR, VERTICAL, VARIABLE, $\pm 90^\circ$
F. POLARIZATION ALIGNMENT ACCURACY	$\pm 0.3^\circ$ WITH RESPECT TO THE RECEIVE VERTICAL POLARIZATION.
<p style="text-align: center;">NOTE</p> <p>¹AT ANY FREQUENCY IN THE SPECIFIED BAND, NO SIDELobe PEAK SHALL EXCEED THIS BOUND BY MORE THAN 3 dB. NO MORE THAN 10% OF THE SIDELobe PEAKS SHALL EXCEED THE SPECIFIED BOUND. REGIONS WITHIN $\pm 15^\circ$ FROM EACH SUBREFLECTOR SUPPORT SPAR ARE EXEMPT FROM SIDELobe LIMITATIONS.</p>	

Table 5-3. Ku-band Receive RF Characteristics

A. OPERATING FREQUENCY BAND	13.402 TO 14.062 GHz
B. G/T ¹ <ul style="list-style-type: none"> •A. DANZANTE/CACIQUE •B. GRGT⁴ 	<p>40.3 dB/°K, MINIMUM OVER THE RECEIVE BAND</p> <p>36.3 dB/°K, MINIMUM OVER THE RECEIVE BAND</p>
C. SIDELobe PATTERN <ul style="list-style-type: none"> •A. DANZANTE² •B. CACIQUE •C GRGT² 	<p> $G \leq 29-25 \log_{10}\theta \text{ dBi}$ $1^\circ < \theta < 36.4^\circ$ $G \leq -10 \text{ dBi}$ $36.4^\circ \leq \theta \leq 180^\circ$ </p> <p>SIDELobe LEVELS SHALL BE 16 dB OR MORE BELOW THE MAIN LOBE.</p> <p> $G \leq 29-25 \log_{10}\theta \text{ dBi}$ $1^\circ < \theta \leq 7^\circ$ $G \leq 32-25 \log_{10}\theta \text{ dBi}$ $7^\circ < \theta < 48^\circ$ $G \leq -10 \text{ dBi}$ $-748^\circ \leq \theta \leq 180^\circ$ </p> <p>WHERE G IS THE GAIN (IN dBi), AT ANY FREQUENCY IN THE SPECIFIED FREQUENCY BAND, AND θ IS THE OFF-BORESIGHT ANGLE IN DEGREES.</p>
D. POLARIZATION	LINEAR, VERTICAL AND HORIZONTAL OUTPUTS
1. POLARIZATION 1	VERTICAL, DEDICATED KSA
2. POLARIZATION 2	HORIZONTAL, COMPOSITE SIGNAL INCLUDING SSA-1 AND SSA-2, ONE KSA CHANNEL AND THE TT&C CHANNELS
E. POLARIZATION ISOLATION ³	30 dB MINIMUM
F. POLARIZATION ORIENTATION	$\pm 90^\circ$ FROM LOCAL VERTICAL, ORIENTATION OF BOTH POLARIZATIONS SHALL BE ALIGNED SIMULTANEOUSLY.
G. POLARIZATION ALIGNMENT ACCURACY	POLARIZATION 1, $\pm 0.3^\circ$ WITH RESPECT TO THE TDRS POLARIZATION 1 TRANSMITTED SIGNAL.

Table 5-3. Ku-band Receive RF Characteristics (Continued)

NOTES

¹THE SPECIFIED G/T PERFORMANCE (CLEAR SKY) SHALL INCLUDE TRACKING LOSS (AT ELEVATION ANGLES OF 5° OVER THE LOCAL HORIZON AND WHENEVER THE SUN IS ± 1° OR GREATER OFF THE ANTENNA BORESIGHT) AND SHALL INCLUDE THE TOTAL CONTRIBUTION FROM THE LNA, ASSOCIATED WAVEGUIDE SWITCHES, COUPLERS AND OUTPUT WAVEGUIDES.

²AT ANY FREQUENCY IN THE SPECIFIED BAND, NO SIDELobe PEAK SHALL EXCEED THIS BOUND BY MORE THAN 3 dB. NO MORE THAN 10% OF THE SIDELobe PEAKS SHALL EXCEED THE SPECIFIED BOUND. REGIONS WITHIN ± 15° FROM EACH SUBREFLECTOR SUPPORT SPAR PLANE ARE EXEMPT FROM SIDELobe LIMITATIONS.

³POLARIZATION ISOLATION REQUIREMENT APPLIES TO PORTS 1 AND 2 (FIGURE 5-3) FOR ALL POSSIBLE POLARIZATION ORIENTATIONS. POLARIZATION ISOLATION FOR PORT 1 IS DEFINED AS THE RATIO OF THE POWER RECEIVED AT PORT 1 (EXCITED PORT) TO THAT RECEIVED AT THE ORTHOGONAL (PERPENDICULAR) PORT 2 WHEN AN ELECTROMAGNETIC WAVE (SIGNAL) WITH A PERFECTLY LINEAR POLARIZATION AND PERFECT ALIGNMENT WITH PORT 1 POLARIZATION IS INCIDENT ON THE ANTENNA APERTURE. POLARIZATION ISOLATION FOR PORT 2 IS DEFINED AS THE RATIO OF THE POWER RECEIVED AT PORT 2 TO THAT RECEIVED AT THE ORTHOGONAL PORT 1 WHEN AN ELECTROMAGNETIC WAVE WITH PERFECTLY LINEAR POLARIZATION AND PERFECTLY ORTHOGONAL TO THE POLARIZATION OF THE WAVE DEFINED ABOVE IS INCIDENT ON THE ANTENNA APERTURE.

⁴THE G/T AT GRGT INCLUDES 0.8 dB LOSS THROUGH A RADOME.

- b. The Antenna Subsystem, in conjunction with the USS forward service equipment, shall satisfy the additional performance requirements of Table 5-12 (SSA), 5-19 (KSA), and 5-25 (MA).
- c. The Antenna Subsystem, in conjunction with the USS return service equipment, shall satisfy the additional performance requirements of Sections 5.3.2.3.1.6 (SSA), 5.3.2.3.2.6 (KSA), and 5.3.2.3.3.6 (MA).
- d. The Antenna Subsystem, in conjunction with the TTCS uplink equipment, shall satisfy the additional performance requirements of Sections 5.4.3.1 (command uplink) and 5.4.3.4 (pilot signal).
- e. The Antenna Subsystem, in conjunction with the TTCS downlink equipment, shall satisfy the additional performance requirements of Sections 5.4.3.2.2 (equipment characteristics) and 5.4.3.7 (telemetry data demodulation/detection).
- f. The required S-band transmit and receive RF characteristics shall be as specified in Tables 5-4 and 5-5, respectively (Danzante and GRGT only).
- g. The third SGLT antenna at each Danzante and Cacique shall be capable of executing the associated cutover switching functions, starting from the last controlled position, in ten minutes.
- h. The associated switching arrangement for the third SGLT antenna at each Danzante and Cacique shall introduce no insertion loss in RF paths greater than 0.3 dB.

Table 5-4. S-band Transmit RF Characteristics (Danzante and GRGT Only)

A. TRANSMIT FREQUENCY	2.0359625 GHz
B. RF BANDWIDTH (3 dB)	3 MHz, MINIMUM
C. EIRP (MINIMUM INCLUDING POINTING LOSS) •A. DANZANTE and CACIQUE •B. GRGT	73.5 dBW <u>73.5 dBW</u> <u>70.5 dBW</u>
D. TRANSMIT GAIN	43.5 dBi, MINIMUM
E. SIDELOBE PATTERN ¹ •A. DANZANTE ¹ •B. GRGT ¹	$G = 52 - 10\log(D/\lambda) - 25\log(\theta)$ dBi, FOR $100 \frac{\lambda}{D} \leq \theta \leq \frac{D}{5\lambda}$ $G \leq 29 - 25 \log_{10} \theta$ dBi —42° < θ < 748° $G \leq -10$ dBi —748° ≤ θ ≤ 180° WHERE G IS THE GAIN (IN dBi) AT ANY FREQUENCY IN THE SPECIFIED FREQUENCY BAND AND θ IS THE OFF-BORESIGHT ANGLE IN DEGREES. D = DIAMETER OF ANTENNA (METERS) λ = WAVELENGTH AT TRANSMIT FREQUENCY (METERS)
F. POLARIZATION	RIGHT-HAND CIRCULAR
G. ANTENNA AXIAL RATIO	2 dB, MAXIMUM
<p style="text-align: center;">NOTE</p> <p>¹AT ANY FREQUENCY IN THE SPECIFIED BAND, NO SIDELOBE PEAK SHALL EXCEED THIS BOUND BY MORE THAN 3 dB. NO MORE THAN 10% OF THE SIDELOBE PEAKS SHALL EXCEED THE SPECIFIED BOUND.</p>	

Table 5-5. S-band Receive RF Characteristics (Danzante and GRGT Only)

A. RECEIVE FREQUENCY	2.211 GHz
B. RF BANDWIDTH (3 dB)	3 MHz, MINIMUM
C. G/T ¹	21.5 dB/°K, MINIMUM
D. SIDELOBE PATTERN ² •A. DANZANTE ¹	$G = 52 - 10\log(D/\lambda) - 25\log(\theta)$ dBi, FOR $100 \frac{\lambda}{D} \leq \theta \leq \frac{D}{5\lambda}$

**Table 5-5. S-band Receive RF Characteristics (Danzante and GRGT Only)
(Continued)**

•B. GRGT ¹	$G \leq 2932 - 25 \log_{10} \theta \text{ dBi}$ $42^\circ < \theta < 748^\circ$ $G \leq -10 \text{ dBi}$ $748^\circ \leq \theta \leq 180^\circ$ WHERE G IS THE GAIN (IN dBi) AT ANY FREQUENCY IN THE SPECIFIED FREQUENCY BAND AND θ IS THE OFF-BORESIGHT ANGLE IN DEGREES. D = DIAMETER OF ANTENNA (METERS) λ = WAVELENGTH AT TRANSMIT FREQUENCY (METERS)
E. POLARIZATION	RIGHT-HAND CIRCULAR
F. ANTENNA AXIAL RATIO	2 dB, MAXIMUM
NOTES	
¹ THE SPECIFIED G/T PERFORMANCE (CLEAR SKY) SHALL INCLUDE POINTING LOSS (AT ELEVATION ANGLES OF 5° OVER THE LOCAL HORIZON AND WHENEVER THE SUN IS ± 1° OR GREATER OFF THE ANTENNA BORESIGHT) AND SHALL INCLUDE THE TOTAL CONTRIBUTION FROM THE LNA, ASSOCIATED WAVEGUIDE SWITCHES, COUPLERS AND OUTPUT WAVEGUIDES. ² AT ANY FREQUENCY IN THE SPECIFIED BAND, NO SIDELobe PEAK SHALL EXCEED THIS BOUND BY MORE THAN 3 dB. NO MORE THAN 10% OF THE SIDELobe PEAKS SHALL EXCEED THE BOUND.	

5.2.3.2 Polarization Control

To achieve the polarization performance requirements of Section 5.2.3.1, the following polarization control requirements shall apply:

- a. Polarization Alignment.
 1. Type Mechanical rotation of polarizer.
 2. Rotation range $\pm 90^\circ$ (minimum).
 3. Slew rate 0.5°/second (minimum).
 4. Rotation accuracy $\pm 0.3^\circ$ (3 sigma) relative to command angle.
 5. Readout resolution $\leq 0.1^\circ$.
 6. Readout accuracy $\pm 0.1^\circ$ relative to actual polarization angle not including readout resolution.
- b. Modes Of Operation.
 1. TOCC Manual Control (Danzante and Cacique only).
 2. Local control via the Local Control Panel.

5.2.3.3 Isolation

- a. Transmit/Receive Signal Isolation. The Antenna Subsystem, in conjunction with the USS, shall provide an RF transmit signal such that the combined power of all interference signals introduced by this signal into the antenna receive feed is more than 12 dB below the received desired power corresponding to 10^{-5} probability of error.
- b. •A. Danzante/GRGT
 Ku-band Transmit/Receive Feed Isolation. The Ku-band transmit feed port to either Ku-band receive feed port isolation shall be 35 dB minimum at any frequency in the operating bands.
 •B. Cacique
 Ku-band Transmit/Receive Feed Isolation. The Ku-band transmit feed port to either Ku-band receive feed port isolation shall be 25 dB minimum at any frequency in the operating bands.
- c. S-band transmit/receive feed isolation (Danzante and GRGT only). The S-band transmit feed port to the S-band receive feed port isolation shall be 30 dB minimum at any frequency in the operation bands.

5.2.3.4 Mechanical Characteristics

Table 5-6 specifies the required Antenna Subsystem mechanical characteristics.

Table 5-6. Mechanical Characteristics

A. AXIS CONFIGURATION	ELEVATION OVER AZIMUTH
B. ANGULAR COVERAGE •A. DANZANTE/CACIQUE 1. AZIMUTH 2. ELEVATION •B. GRGT —1. AZIMUTH —2. ELEVATION	$\pm 90^\circ$ (DEAD ZONE NORTH) 0° TO $+ 92^\circ$ $\pm 180^\circ$ 0° TO 92°
C. ANGULAR DYNAMIC CAPABILITY (EACH AXIS) 1. ANGULAR VELOCITY 2. ANGULAR ACCELERATION	0.002°/SEC TO 0.5°/SEC 0.5°/SEC ²
D. WINDS •A. DANZANTE/CACIQUE 1. SURVIVAL - ANY POSITION 2. SURVIVAL - STOW POSITION •B. GRGT 1. SURVIVAL - ANY POSITION	UP TO 130 km/HOUR UP TO 193 km/HOUR A RADOME SHALL BE PROVIDED AT THE GRGT AND SHALL BE TYPHOON RATED TO 200 MPH WINDS

8.1.6 Data Link Monitoring (DLM)

The DLM Subsystem shall monitor the outgoing composite multiplexed data signal (≤ 10 Mbps each) to the GSFC/JSC CC interface and the incoming composite data signals (≤ 10 Mbps each) from the GSFC/JSC CC interfaces. The DLM subsystem shall also monitor the outgoing composite multiplexed data streams entering the cross-strapping multiplexers, the multiplexed data being sent to the recorders, the outputs of the HDR multiplexers, the inputs (50 Mbps) to the HDR demultiplexers from the inter-terminal interface, and the high data rate (50 Mbps) data streams to the inter-terminal interface and the GSFC/JSC CC interface. The DLM subsystem, in conjunction with the DIS ADPE subsystem, shall support the selection of prime/redundant equipment in the DIS and the selection of GSFC/JSC CC interfaces as shown in Figures 8-2 and 8-6.

8.1.7 DIS Modular Expandability

The implementation of the DIS shall provide for modular expandability of throughput and interfaces without service interruption of existing equipment. Expandability shall include but not be limited to:

- a. Installation of additional CC interfaces to support increased throughput.
- b. Increasing the data rates of forward service support from 7 Mbps to 25 Mbps.
- c. Expansion of the Communications Switch low rate multiplexer input ports to 128 and the low rate demultiplexer output ports to 64 per demultiplexer.
- d. Increasing GRGT user data transport capabilities to those specified for low rate customer forward and return data in Section 8.1.5.1 and for high rate customer return data up to 50 Mbps.

8.1.8 GDIS (Cacique and GRGT only)

The GDIS, at each Cacique and GRGT, shall provide the capability to process and transport secure and Black data between Cacique and GRGT. The GDIS shall perform the following functions in support of the GDIS reference architecture and functional flow as shown in Figure 8-9:

- a. Multiplexing and demultiplexing of all data transmitted between Cacique and GRGT.
- b. Encryption and decryption of all ~~secure~~-operational sensitive data transmitted between Cacique and GRGT.
- c. Multiplexing and demultiplexing of all ~~secure~~-operational sensitive data prior to encryption and decryption, as necessary, to minimize the number of cryptographic devices required.
- d. Processing of Shuttle return TV and digital data.

8.2 DIS Functional Requirements

The DIS shall execute the following functions:

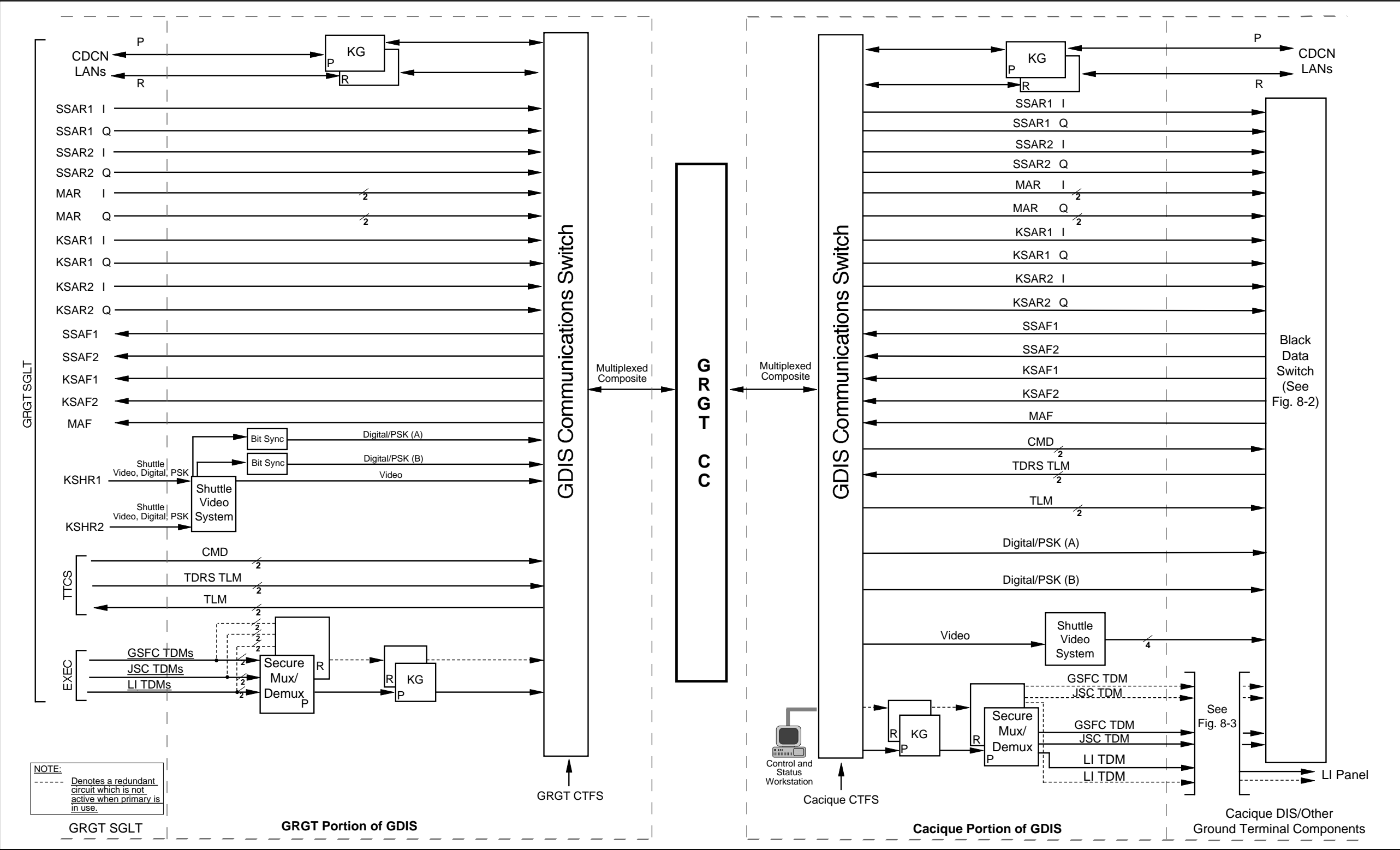


Figure 8-9. GDIS Reference Architecture and Functional Flow

8.2.17.5.3 Demultiplexing

The GDIS Communications Switch shall be capable of receiving multiplexed data from the GRGT CC interface and routing demultiplexed serial bit-contiguous, and digitized Shuttle TV data as shown in Figure 8-9. The GDIS Communications Switch shall first check the error code field for validity before routing the serial bit-contiguous data.

During periods of time (intervals greater than one second) when a GDIS Communications Switch demultiplexer output port is not receiving data from the transmitting GDIS Communications Switch, the GDIS Communications Switch will receive a circuit assurance block transmitted from the remote GDIS Communications Switch, and shall route the blocks to the output port for processing. Circuit assurance blocks shall be inhibited from being transmitted from the GDIS Communications Switch demultiplexer output ports.

8.2.17.5.4 GDIS Communications Switch Control

The Cacique DIS ADPE shall provide the capability to enable/disable the GDIS Communications Switch input and output ports. Configuration/reconfiguration shall be in response to SHOs and OPMs received from the NCC.

A control and status workstation shall be provided at Cacique to configure and maintain status on the Cacique and GRGT segments of the GDIS Communications Switch. The GDIS Communications Switch shall provide operational status information and alarms to the control and status workstation.

8.2.17.5.5 GRGT CC Interface

The composite data and clock signals for the GDIS Communications Switch interface with the GRGT CC shall be as specified in 530-ICD-GRGT-GCF.

8.2.17.6 GDIS SRDP

The GDIS SRDP shall provide switching and signal processing of Shuttle TV, digital data on Channel 3, Mode 2, and 1.024 MHz Subcarrier. The GDIS SRDP shall select and route the signal from GRGT SGLT USS to the GRGT GDIS Communications Switch.

8.2.17.6.1 TV Processing

The GDIS SRDP at GRGT shall digitize and compress the Shuttle TV data occupying the 20 Hz to 4.2 MHz band received via the KSA analog channel from the GRGT SGLT USS prior to routing the signal to the GDIS Communications Switch. [The GDIS SRDP at GRGT shall also provide video recording for line outage protection.](#) The GDIS SRDP at Cacique shall convert the compressed, digitized Shuttle TV data received from GRGT to an analog signal prior to routing the signal to the Cacique DIS Black Data Switch.

8.2.17.6.2 Digital Data Processing

The GDIS SRDP shall provide signal processing of the digital data on Channel 3, Mode 2 and the 1.024 MHz Subcarrier prior to routing the signal to the GDIS Communications Switch. The signal processing required is clock recovery.